# FORECAST UNCERTAINTY IN THE AWIPS GRAPHICAL FORECAST EDITOR ERA

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## NWS considers forecast uncertainty to be an important topic:

-NWS has commissioned National Research Council to study

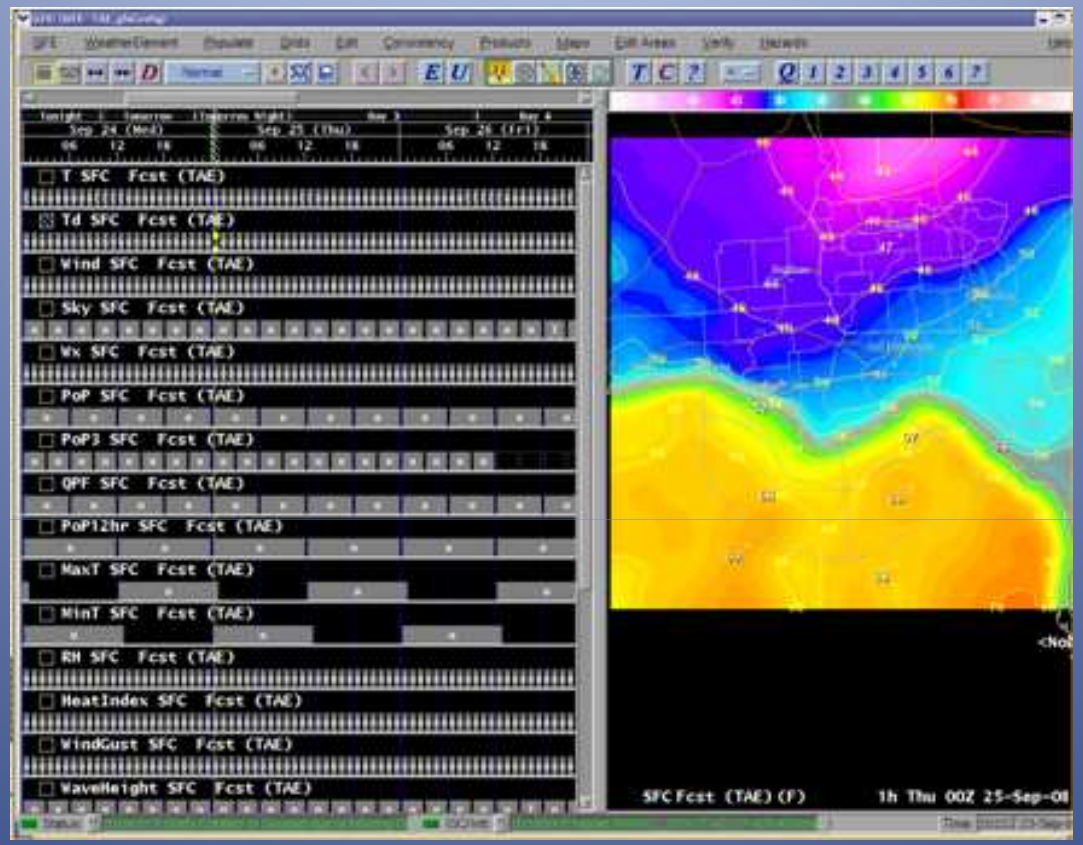
-NWS created a NOAA/NWS Forecast Uncertainty Team

-AMS has created an Ad Hoc team on Uncertainty Forecasts

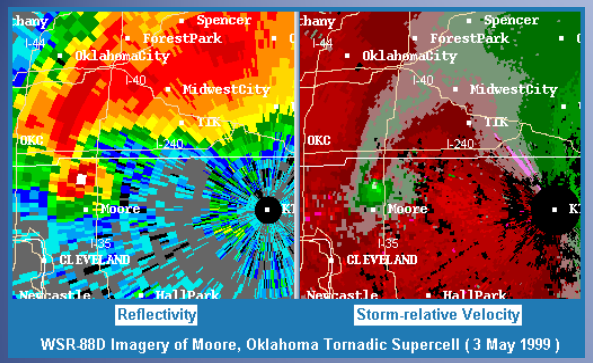
# WFO Tallahassee's Idea…

## "Confidence Grids"

# Motivation:

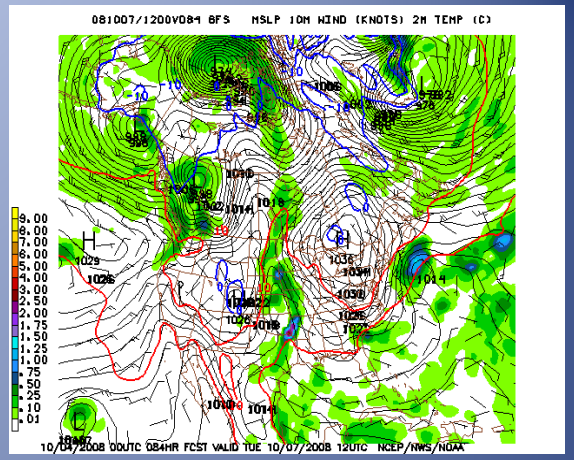



There are about 1000 grids to manage in the Graphical Forecast Editor (GFE).

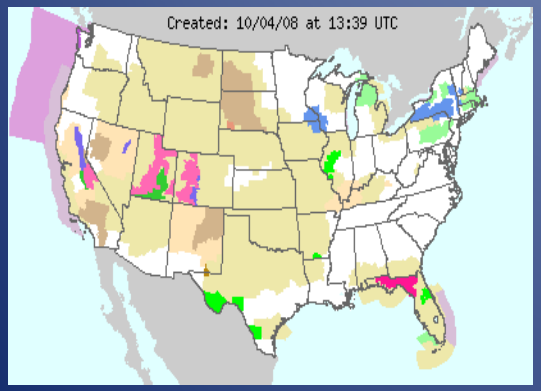



Continuous Wx watch

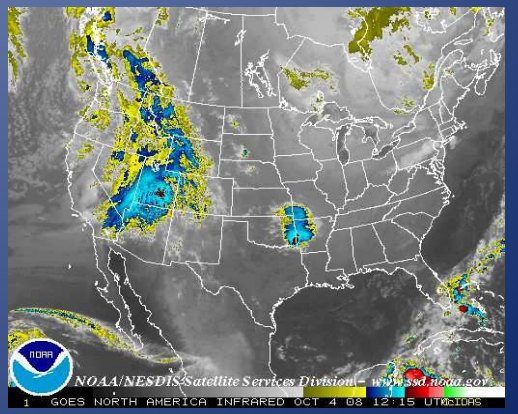
NWS Forecasters need a tool to help focus on potential high impact weather events




NWP analysis



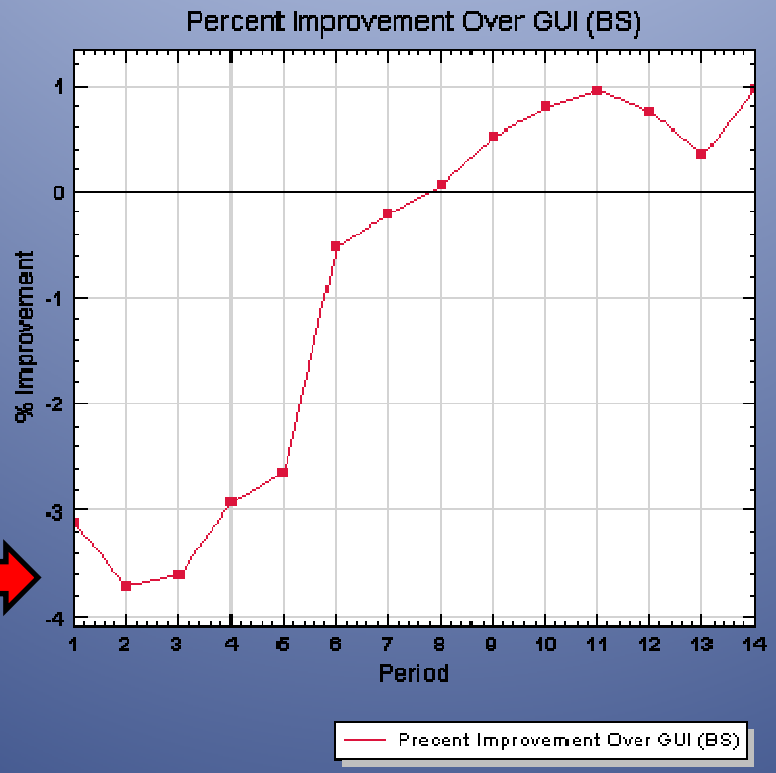

Work with other offices to maintain NDFD



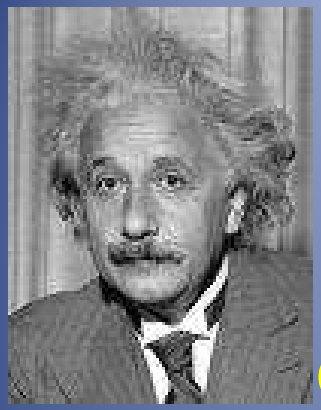

Data analysis

# Is it worth spending several hours on an entire forecast cycle for nearly imperceptible improvements to the numerical guidance?

NWS made a 3.7% improvement over MOS




PoP verification for the NWS Southern Region
from April 2007 – April 2008
(Courtesy of NWS verification website)

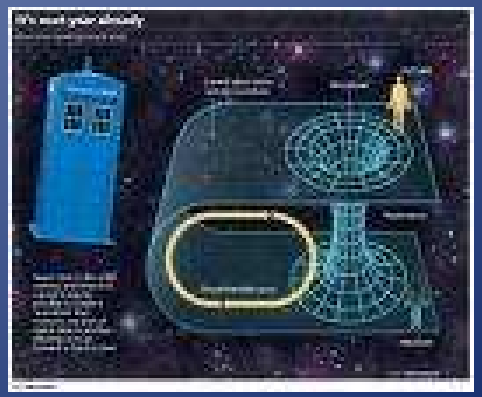


## Conundrum:

One must “know” ahead of time if, when, & where high impact weather events will occur in order to plan on adjusting time & resources to better forecast such events

*“If you haven’t anticipated it, you probably won’t recognize it when it happens”*

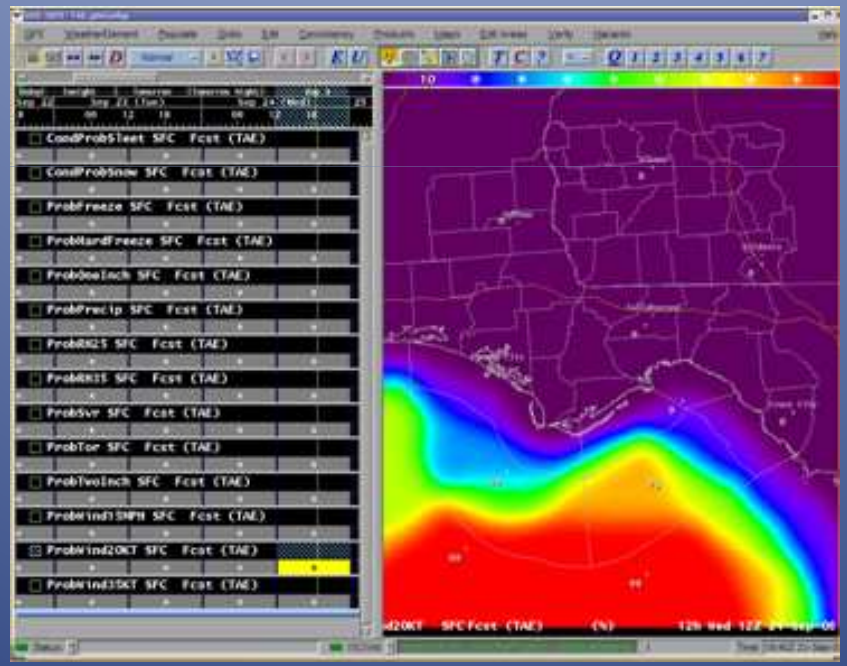
-C. Doswell



## Possible solution:

## “Confidence Grids”

Use local thresholds for watches/warnings
as definitions of high impact weather events,
then use NWP guidance to determine likelihood
of thresholds being reached




Probability of 20KT winds in a 12-hour period
on Day 2 of forecast

## The following “Confidence Grids” are computed:

### Fire Weather:
Min RH < 35%
Min RH < 25%
Wind >= 15 MPH

### Marine Weather:
Wind >= 20 KT
Wind >= 35 KT

### Winter Weather:
Conditional probabilities of sleet & snow
Min T < 32
Min T < 27

### Other:
12-hour PoP
12-hour probability of 1” of rain
12-hour probability of 2” of rain
probability of tornadoes
probability of severe thunderstorms

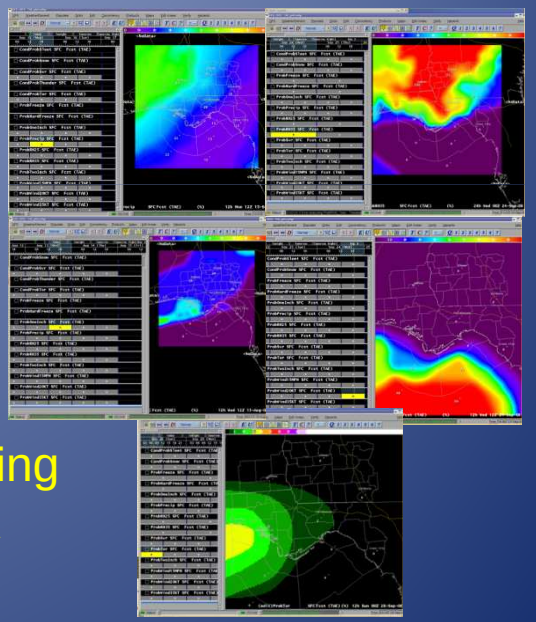
NWP models (GFS, NAM, ECMWF)

MOS (MAV, MET, FWC)

Other (SREF, bias-corrected model output)

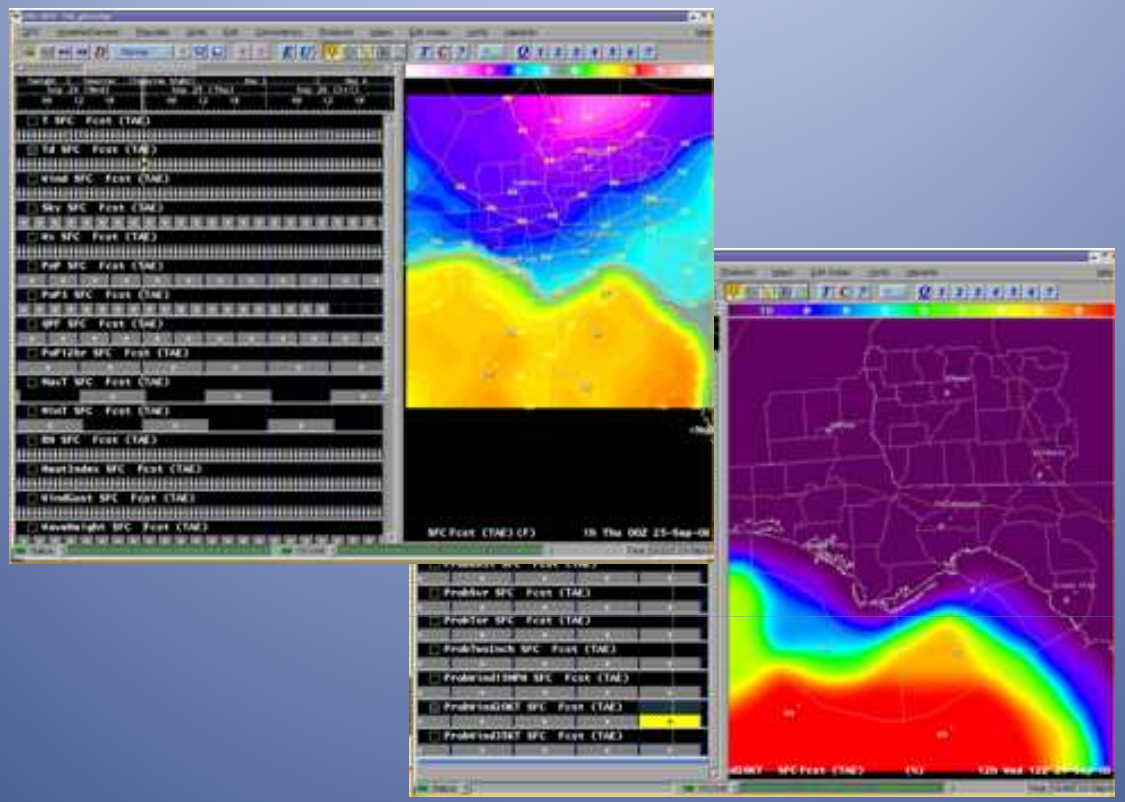
GFE Procedure & Smart tools

Confidence Grids



Confidence grids are a new concept being tested *internally* at WFO Tallahassee. A GFE procedure uses several sets of numerical guidance to produce objective probabilities of an event occurring. These probabilities are displayed as “Confidence Grids” in GFE.

Traditional GFE screen



GFE Confidence Grids

Forecasters can quickly examine 50 Confidence Grids for “problem areas”, instead of looking through 1000 grids and/or NWP output

## Methodology:

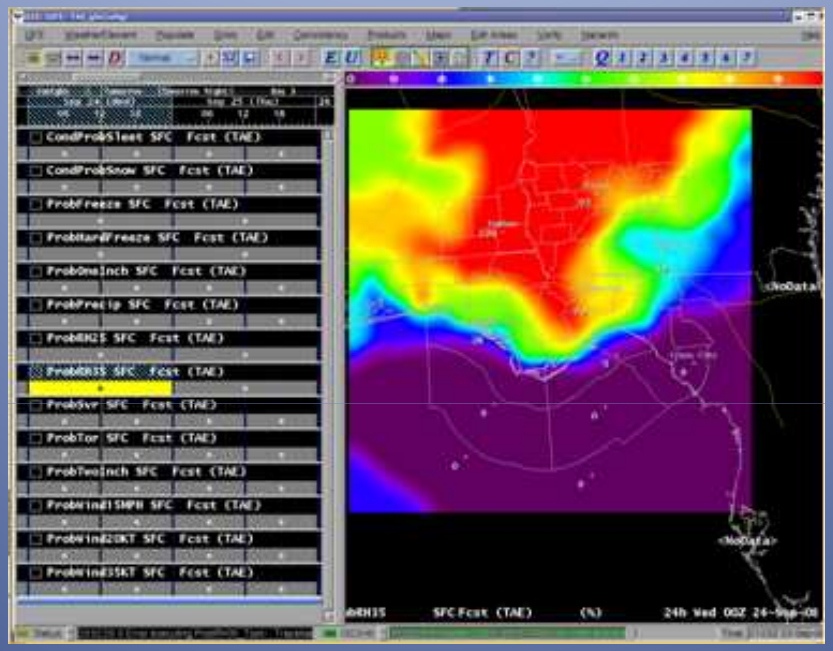
-Use Short Range Ensemble Forecast (SREF) as a template
  -probabilities of important thresholds being met

-Incorporate as much variety of NWP as possible
  -older guidance (FWC & MET) may still be useful in some situations

-Use MOS and raw model output
  -raw model output has some skill in forecasting wind & RH
    -NAM does particularly well forecasting Min RH on fair weather days with strong vertical mixing

-Some compromises needed
  -Confidence grids only go out 60 hours (from 12/00 UTC) so FWC can be used
  -No grids resolution higher than 12 hours so ECMWF can be used

For most of the Confidence Grids, the concept is very simple. What percentage of commonly-used NWP guidance are forecasting a particular event?




Probability of relative humidity below 35%...

(NAM rh_yes + ECMWF rh_yes + MAV rh_yes + MET rh_yes + FWC rh_yes) / 5

## How can we use Confidence Grids in day-to-day operations?

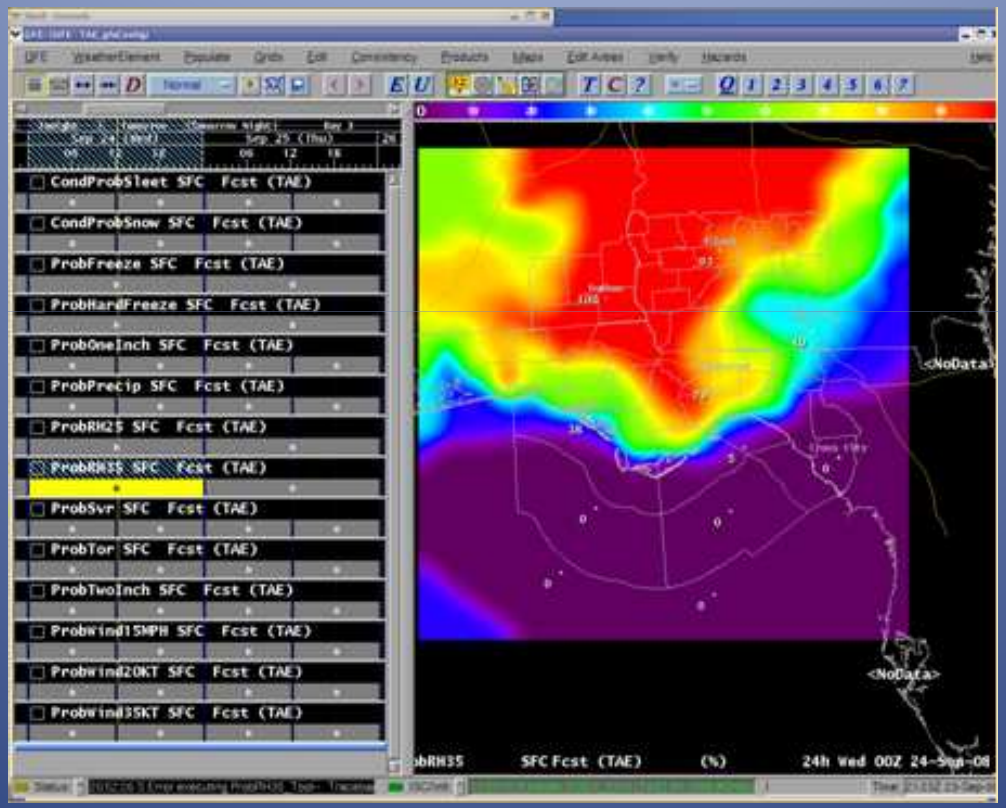
"Anything going on, Homer?"


"No Lenny…nothing but high pressure!"

Typical shift change during "fair weather"

Run the GFE procedure that produces Confidence Grids, then examine these grids for “problem areas”.

Suppose Homer was right, and the Confidence Grids show no precipitation, high winds, or freezes. *But*…




Probability of relative humidity below 35%

The Confidence Grids for low RH indicate a good chance for Red Flag Warning conditions the next day.

With this foreknowledge, the forecaster can concentrate his/her time & effort on producing the best RH forecast possible.

-Compare raw model output (advection)

-Compare forecast soundings (vertical mixing potential)

-Compare MOS (temperatures & dewpoints)

-Apply local knowledge (persistence, climatology, recent verification)

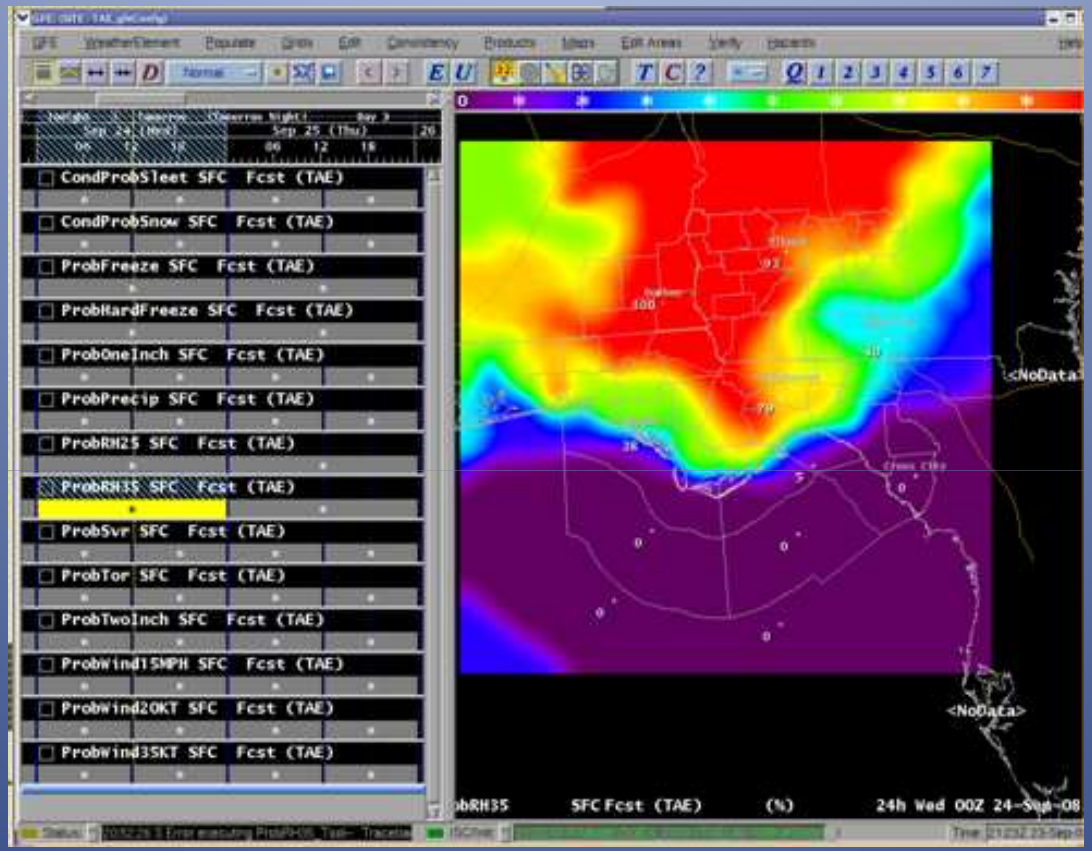
-Coordinate with other offices & SPC

-Examine forecast in context of situational awareness

-Is there a heightened sensitivity to fire danger?

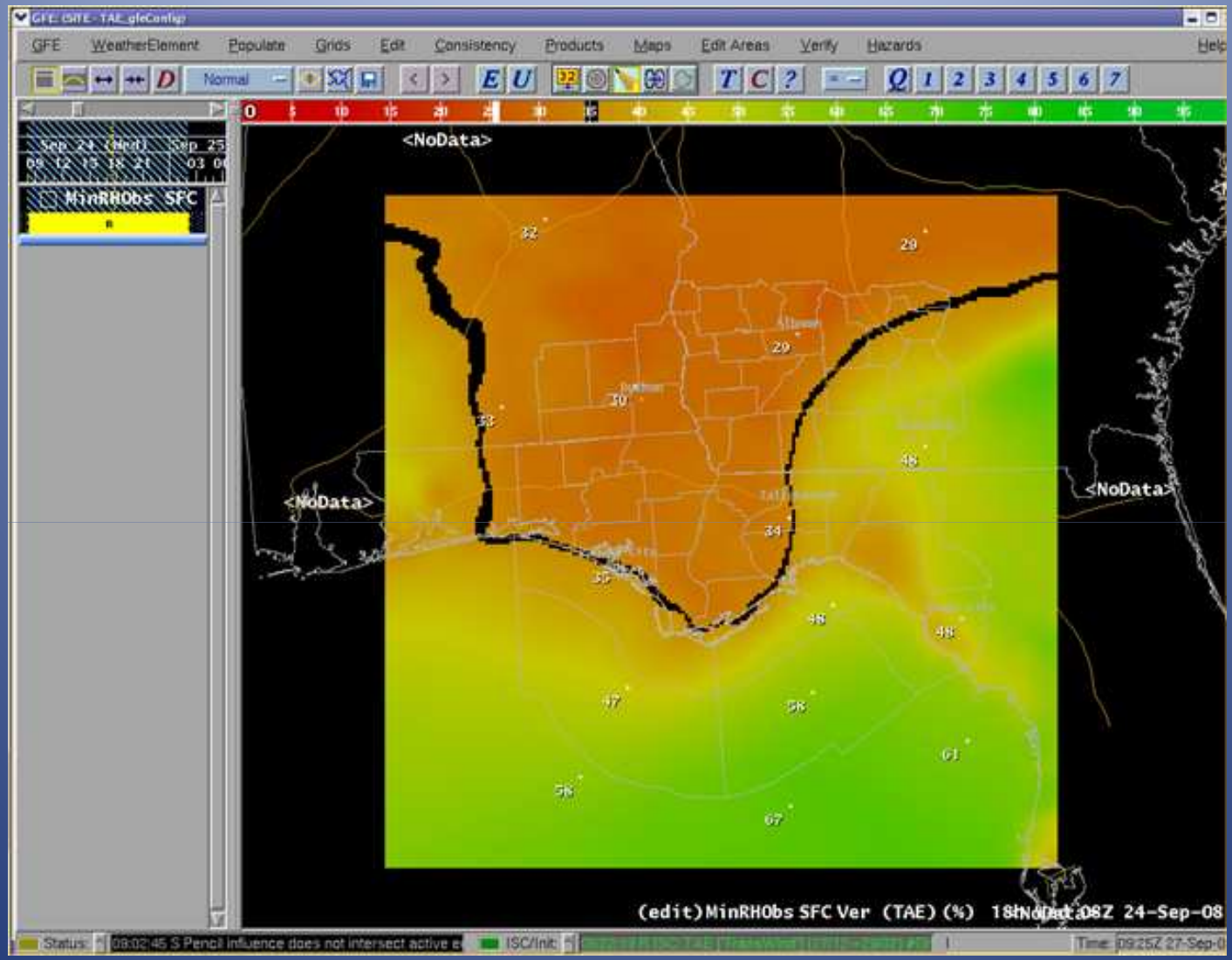
-wild fires, controlled burn season, etc.

The probabilities in Confidence Grids can be used directly in the warning decision process, in a similar way to how NHC uses their probabilities to issue watches & warnings.




In this case, perhaps we could use the 50% probability line (of RH < 35%) to define our Red Flag Warning boundary for Florida

# That strategy would have worked well in this case

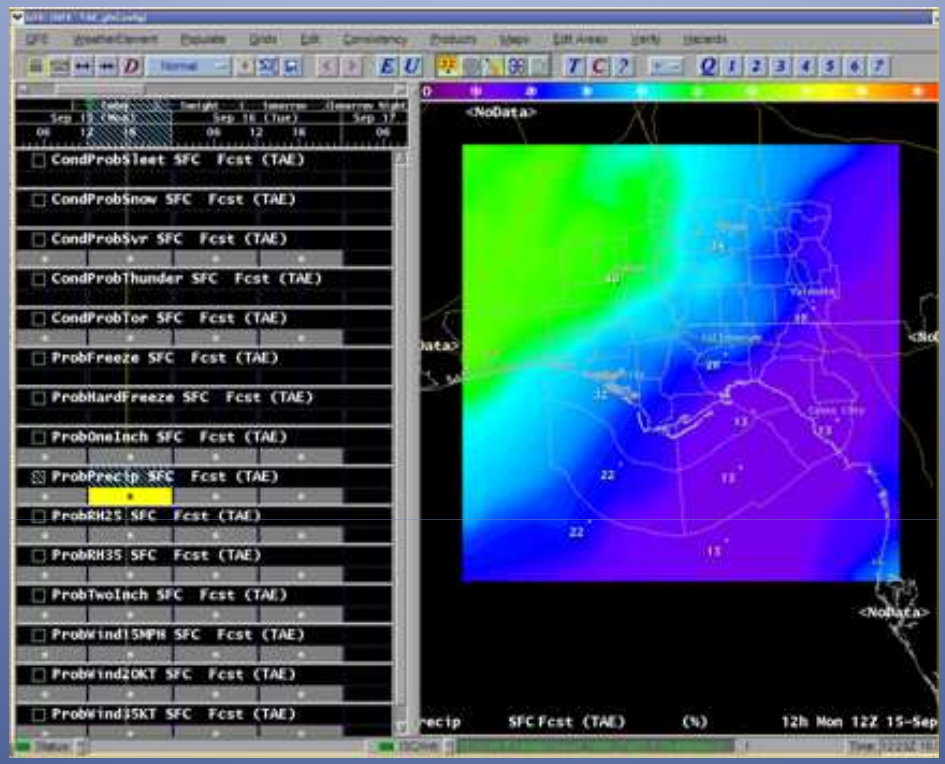



Observed Min RH the next day. (Black line is the 35% RH line)

# Another advantage of Confidence Grids…the ability to express (quantitatively) confidence in a forecast to our customers & partners


"How ***sure*** are you that the winds will stay below 15 MPH today?"

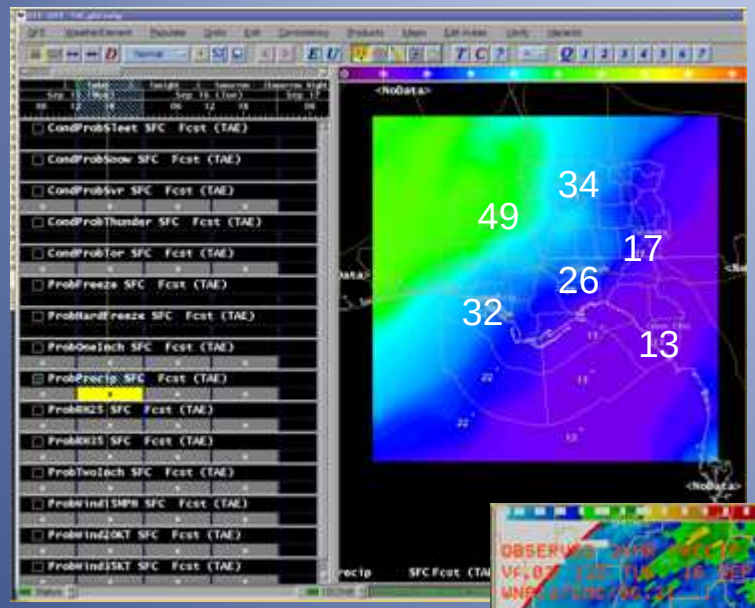
# Some of the Confidence Grids use a more complex approach…like PoP



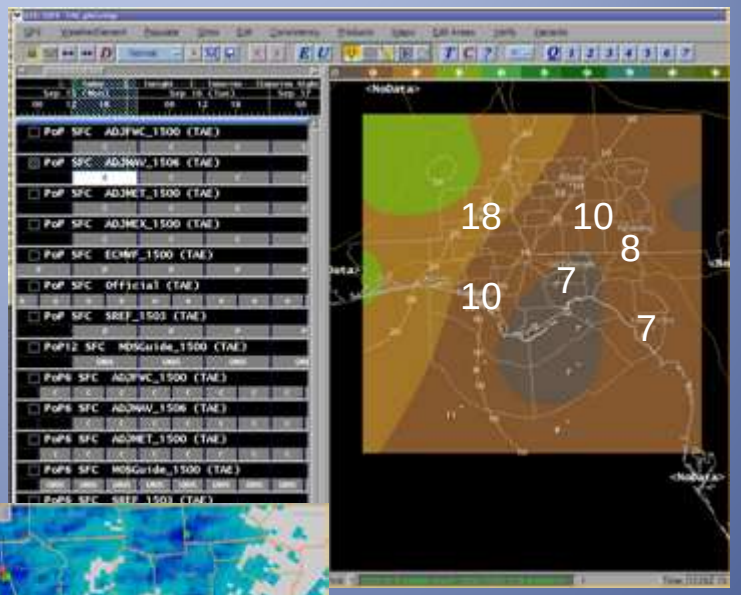

[(Percentage of GFS, NAM, & ECMWF QPF >= 0.01 inch) + SREF PoP]  / 2 = Prob

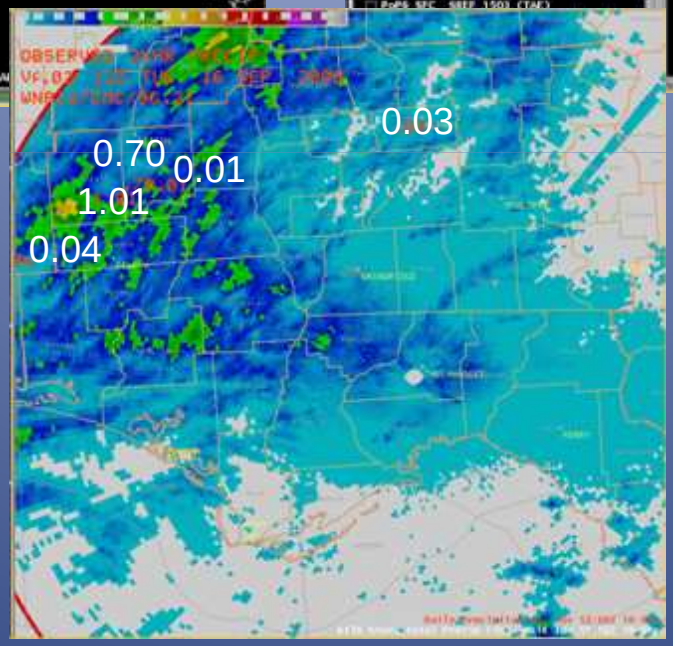
PoP = (Prob + MAV + MET + FWC) / 4

Confidence Grid 12-hour PoP



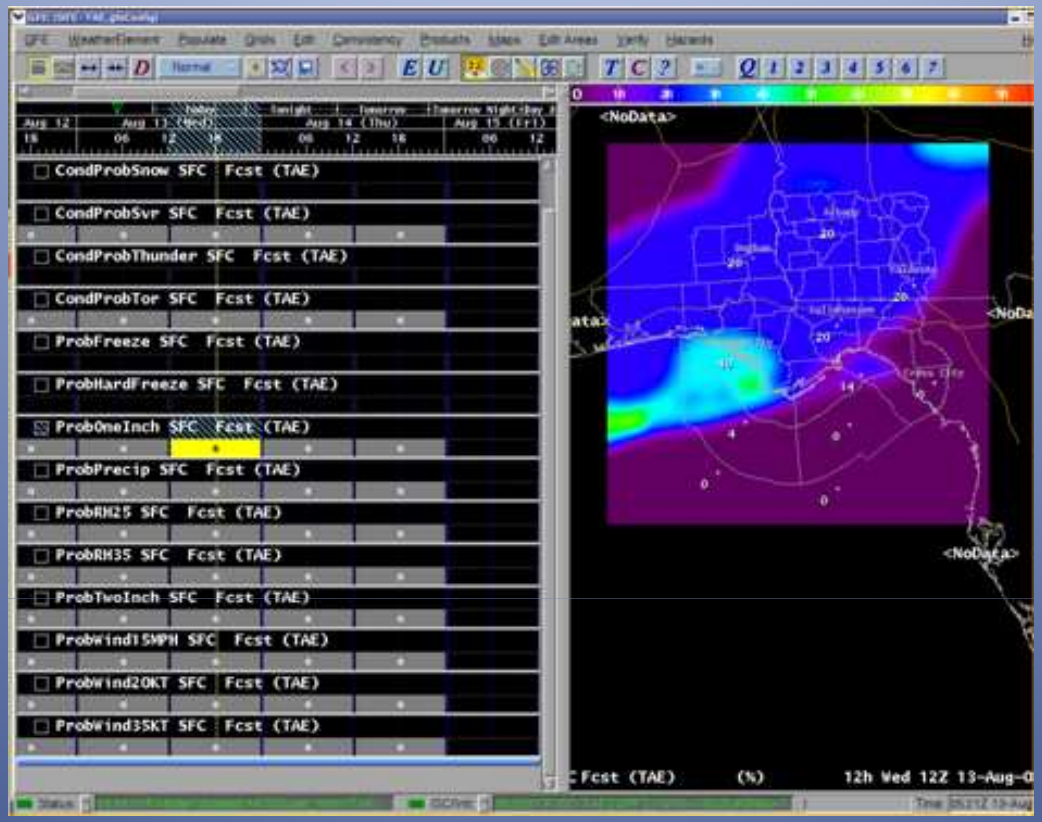

MAV 12-hour PoP




QPE from KTLH Radar & actual gage values

# What is the chance of getting 1 inch or more of rain?




(Percentage of GFS, GFSMOS, NAM, & ECMWF QPF >= 1 inch) = Prob

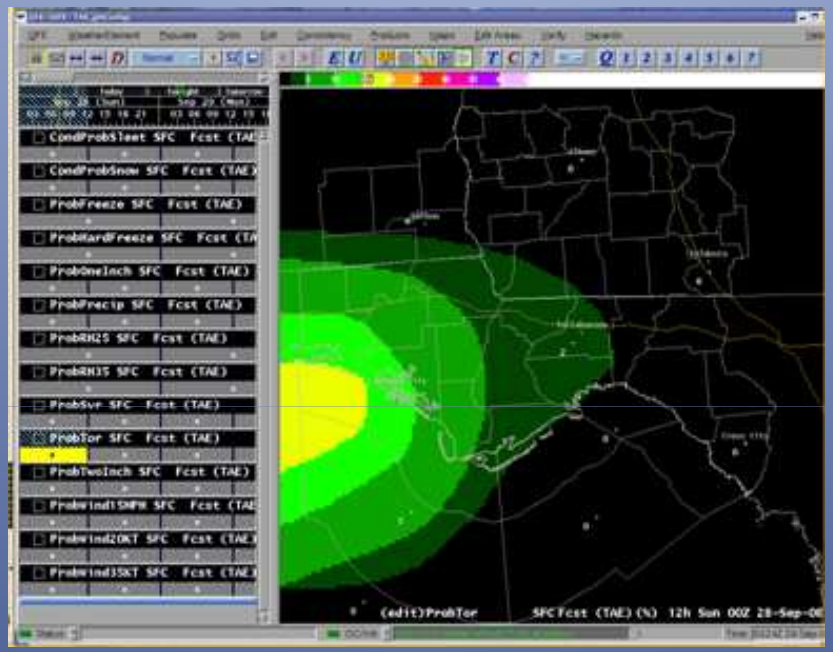
Probability of One inch of rain in 12 hours = (0.8 * Prob) + (0.2 * SREF Prob >= 1 inch)

(The same method is used for 2 inches or more)

Before Tropical Storm Fay dumped historic rain amounts over our area, EMs wanted to know not only how much rain would fall, but how confident we were in our forecast.

Confidence Grids are a tool forecasters can use to express uncertainty using specific values (and not vague terms like *chance*, *possible*, etc.)

# Tornado Confidence Grids




Example of Confidence Grid showing the probability of a tornado occurring within 25 miles of a point

# COOL SEASON SIGNIFICANT (F2-F5) TORNADOES IN THE GULF COAST STATES

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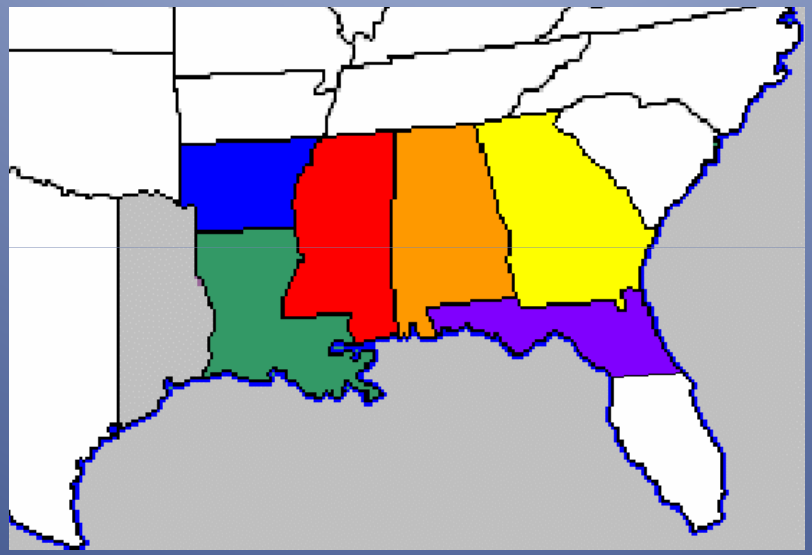
Norman, Oklahoma



Much of our Tornado Confidence Grids is based on this publication, as well as local verification, & calibration with the SPC subjective probability graphics

# Tornado Probability Methodology:

-Only GFS & NAM winds & CAPE (limited ECMWF output in GFE)
-Computes 0-1km & 0-6km vertical wind shear
-Uses SBCAPE (0-3km & MLCAPE CAPE not available in GFE)
-Takes mean of NAM, FWC, MAV, & MET dewpoints

-If minimum thresholds are not met for shear, CAPE, *or* dewpoint, the threat is zero

-Shear values & CAPE are assigned a favorability rating (2, 5, 10, 15, 30, 45)
    -the higher the value, the higher the rating

-These scores are averaged together
    -if the PoP < 50%, the score is multiplied by PoP
    -dewpoints can only hurt the overall rating

-The resulting score is the overall probability of a tornado occurring within 25 miles of a point

## Tornado Confidence Grids can be used in conjunction with the SPC probabilities.

-Grids can provide 12-hour resolution of threat
-Can be run out through 60 hours
-Can be run with each new model cycle
-Are tailored to local tornado climatology

-Preliminary indications are that the Tornado Confidence Grids often match well with SPC, but tend to be “noisier” and have trouble “catching” low-end threats (Wednesday, October 8)

## CONFIDENCE GRIDS CONCEPT ADVANTAGES:

1) Allows forecasters to quickly assess potential high impact weather events during next 60 hours

2) Forecasters can place more emphasis on the expected events (model analysis, weather briefings, extra staffing, inter-office coordination, etc.) during the forecast process

3) The probabilities can be used to help decide if, when, & where to issue advisories/watches/warnings

4) Forecasters can give an explicit expression of confidence in an event occurring, instead of using vague terms like *possible* or *chance*

# Thank you for your time. Any Questions?

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